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PACIFIC NORTH WEST FOREST AND RANGE EXPERIMENT STATION

USDA FOREST SERVICE RESEARCH NOTE

PNW-222 *March 1974*

A SUGGESTED METHOD FOR COMPARING CONTAINERIZED AND BARE-ROOT SEEDLING PERFORMANCE ON FOREST LANDS

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FOREST AND RANGE
PERIMENT STATION
SEP 13 1974
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ABSTRACT

Procedures are proposed for making uniform field comparisons of containerized and bare-root nursery stock. If such comparisons are made in many areas, enough data can be cooperatively accumulated from which to develop sound guidelines for use of containerized seedlings.

Keywords: Nursery stock, outplanting, research.

INTRODUCTION

Containerized seedlings are being produced and outplanted by the millions on forest lands in the Pacific Northwest. Approximately 23 million were grown in Oregon and Washington greenhouses and nurseries in 1973, and it appears 1974 production will increase by at least 10 million.[1/] Most containerized stock is grown from seed in plastic or styrofoam containers holding various mixtures of peat moss, vermiculite, tree bark, perlite, and sand. Before outplanting, seedlings are extracted from their containers and their compact roots hold together a semirigid plug of potting mix.

Rapid expansion of container reforestation systems in the past several years is undoubtedly due to their managerial and operational advantages: Production can be expanded rapidly with less capital investment in land and equipment than is needed for bare-root nurseries; less leadtime is necessary between reforestation planning and planting; roots are less exposed; and seedlings can be planted more quickly during longer seasons than for bare-root stock. But how are the huge numbers of "good looking" containerized seedlings performing after outplanting?

FIELD PERFORMANCE TRIALS NEEDED

Published results on field performance in Oregon and Washington are few and preliminary.[2/] Furthermore, available test results are for containerized seedlings produced in earlier stages of the rapidly evolving production technology. This technology has far outdistanced systematic field testing, and concerted effort is urgently needed to adequately evaluate seedling performance. Answers are needed to such questions as: (1) What is the comparative survival and growth

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[1/] Frank A. Ter Bush. Seedling production and capacity. USDA Forest Service Pacific Northwest Region, Forestation Notes No. 20: 1-4. 1973.

[2/] James Dick. Container planting in Oregon and Washington. *In*: Western Reforestation. Western Forestry and Conservation Association Western Reforestation Coordinating Committee Proceedings 1969: 41-44. 1970.

Peyton W. Owston. Field performance of containerized seedlings in the Western United States. Western Forestry and Conservation Association Permanent Association Committees Proceedings 1972: 109-112. 1973.

Peyton W. Owston and William I. Stein. First-year performance of Douglas-fir and noble fir outplanted in large containers. USDA Forest Service Research Note PNW-174, 10 p., illus. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon, 1972.

of containerized and bare-root stock? (2) In which situations do containerized trees outstrip, or fall short of, bare-root stock performance? (3) What are the comparative reforestation costs using bare-root or containerized trees? Much information on field performance and cost must be collected before a comprehensive evaluation of containerized reforestation is possible.

Simple methods for making critical survival and growth comparisons between containerized and bare-root stock are described in the pages that follow.[3/] These methods are used in widespread field trials now being installed in a 5-year pilot program on National Forests in Oregon and Washington. We encourage others to use the same methods. By using the same design and procedures in many localities, enough data will be accumulated from which to develop sound guidelines on use of containerized seedlings on individual ownerships and for regional areas.

Members of the Pacific Northwest Forest and Range Experiment Station seek to cooperate with organizations or individuals interested in evaluating containerized seedling performance. Common use of the sample forms will permit ready pooling of data and standardized analyses. Please contact us to work out cooperative endeavors on a timely basis.

PROCEDURES FOR COMPARING CONTAINERIZED AND BARE-ROOT SEEDLINGS

The installation described below is a reasonable minimum for comparing in one locality a single type of containerized seedling with a single type of bare-root stock of the same species. The basic objective of such a comparison is to answer the question:

> Under the given site conditions, do (species) seedlings grown from seed in (type) containers survive and grow better after outplanting than (size or age class) bare-root stock?

Inferences about different production techniques, species, stock types, and sites may be drawn from results produced by a large number of these individual experiments.

[3/] More intensive and involved tests than those described may sometimes be desirable or needed. Consultation with a statistician is highly recommended before launching any complex study.

PLOT ESTABLISHMENT

Locate four plots (replications) within the locality of interest. All plots may be in one reforestation unit or one plot may be placed in each of four units. The site--soil type, slope, aspect, ground cover, etc.--should be as uniform as possible within each plot, but conditions among plots of a set may be varied or uniform depending upon the information desired; e.g., all four may be on south aspects if that is the main area of interest, or aspect may be varied so that inferences about container planting can be made for the locality in general. Other site factors can be handled similarly. Plot locations should be recorded on a map of the reforestation unit(s). Nearby stumps, logs, and brush can be indicated on sketches of individual plots, if this appears desirable.

Each of the four plots should contain four rows of 25 planting spots each--400 trees for planting at one time in each set of four plots. Comparison of fall and spring planting would require doubling of rows per plot and appropriate random assignment of an equal number of rows for planting in each season. Rows should be oriented up-and-down slope and numbered in order, 1 to 4, or 1 to 8. A field spacing of 6 feet between rows and 6 feet between planting spots is suggested as reasonable for minimum site variation within plots and convenience of remeasurement. Even closer spacings may be used if sufficient good planting spots are available and reduced plot size seems desirable.

The kind of tree to be planted in each row within a plot should be designated at random. An easy way to accomplish such randomization is to drop four folded slips into a hat or box, two bearing the word "bare-root" and two "container." Row 1 receives the stock listed on the first slip drawn sight unseen after shaking the hat, row 2 the next, and so on. When a fall vs. spring planting comparison is included, eight rows are involved and eight slips are used, two each labeled bare-root fall, bare-root spring, container-fall, and container-spring. Random assignment of stock to rows should be made independently for each plot of a set.

To help prevent bias and to obtain well-arranged plots for convenient reexamination, it is advisable to use guide ropes during planting or to stake planting spots in advance with flagged 20-inch wire pins; e.g., red for containerized stock, blue for bare-root stock. Rows should be kept reasonably straight; unplantable spots should be skipped and each row extended far enough to provide

25 plantable spots. Ends of each row should be marked with wooden stakes, except the one for the outside row in each plot ending nearest the access road which should be a tall steel or wooden post. Plots should be signed adequately and rows labelled clearly.

The items and quantity needed for installing a single set of four plots planted in one season are listed below. The 50 extra trees of each kind are to be used for size determination and for those isolated instances when field culling seems prudent.

Item	Number needed
Containerized trees	250
Bare-root trees	250
Steel or wooden posts	4
Wooden stakes (about 3 feet long)	28
Flagged wire pins, red	200
Flagged wire pins, blue	200
Planting tools	Various
Data sheets	Various
Area map	1

PLANTING AND TENDING

Several stock and planting requirements must be met to insure an unbiased comparison of containerized and bare-root trees:

1. Containerized and bare-root stock should be of the same seed source, and both lots should appear healthy and sturdy. Each type of stock should be representative, with extremely large or small seedlings removed to attain a reasonably homogenous sample. They should both be given good and comparable preplanting care--i.e., handling, storage, and transporting should be minimized, and done so that the trees do not become dry, overheated, or physically damaged.

2. Plant only when air temperature is above freezing during actual hours of work, soil is moist and unfrozen, and any snow cover is less than 2 inches deep. Both types of stock should be planted concurrently to minimize unequal effects caused by changing weather, i.e., don't plant one type in the morning and the other in the afternoon.

3. Good planting technique and comparable effort must be used for both types of stock--i. e., vegetation and debris should be removed uniformly from all spots, trees should be planted with roots straight down in mineral soil to a depth between the root collar and the first green foliage, and the soil should be packed tightly enough to prevent air pockets, easy pulling by animals, or frost heaving. No attempt should be made to achieve normal production rates in test plantings.

4. Trees should be planted in the most favorable place within a 2-foot radius of the marked spots. If no plantable ground is found in the designated circle, move on to the next designated spot. Immediately after planting, the wire pin marking each spot should be placed north of and within 4 inches of the tree. Pins should be left in place throughout the study and may be numbered to facilitate tree reexaminations.

5. Ideally, one person should plant the 100 trees in one plot to eliminate planter variation. If this is not done, an honest effort must be made to have individuals plant an equal number of each type of stock. Under no circumstances should one person plant all container seedlings and another person all bare-root stock.

In essence, the person in charge should make every effort to insure that handling and planting procedures do not favor one type of stock over the other.

If one type of stock is treated with animal repellent before or after planting, the other type should also be treated. Other postplanting protection from animals should be provided at the discretion of the forester in charge. Again, both containerized and bare-root trees should be treated similarly; e. g., if not all trees are protected, half of each kind might be caged to prevent browsing.

Wildings of the species being tested should be removed from the plots if their presence might cause confusion initially or during reexaminations.

DATA COLLECTION AND ANALYSIS

A planting report (Form 1) should be completed by the person in charge as soon as a set of plots has been planted. This report provides key information on stock characteristics, site description, and planting conditions. It is also highly desirable to determine initial top length, stem diameter, and dry weight of both containerized and bare-root trees (Form 2). These data are obtained by measuring, drying, and weighing a representative sample of 25 bare-root and 25 containerized trees drawn at random before both lots are planted. Measurement of the sample trees is best done indoors at a workbench; determining ovendry weight will require washing facilities, a drying oven, and a balance. Data obtained from sample trees will characterize the stock used and will aid in interpreting results.

Survival of planted trees should be checked in the first spring after fall planting, and after the first, third, and fifth growing season for both fall and spring plantings (Form 3). A cumulative record should be obtained, which requires keeping track of each tree individually by position in plot and row. An undamaged tree should be considered alive as long as it bears any green foliage; death of a clipped or broken tree is not certain if live cambium is still present on the stub.

Total height of seedlings should be measured at intervals (Form 3). Initial height is useful for later determination of growth. It can be measured immediately after planting or can be determined for most species at the end of the first growing season by measuring from ground line to the point of last bud break. Measurement of total height or of height growth each fall that survival is checked is desirable; but it this is not possible, total height should at least be measured at the end of the third and fifth growing seasons.

Heights, stem diameters, and dry weights of conifer seedlings are determined in a variety of ways. For the sake of uniformity, the procedures listed, which are based primarily on a committee report of the Society of American Foresters,[4/] are recommended:

[4/] Society of American Foresters. Report of the ad hoc committee on nursery stock measurement procedures. Journal of Forestry 67: 52-53. 1969.

Top length

Measure to the nearest centimeter from the base of the terminal bud to the root collar, defined as a point on the stem 2.5 centimeters below the cotyledonary scar.

Stem diameter

Measure to the nearest 0.5 millimeter at a point 2.5 centimeters below the cotyledonary scar.

Total height

Measure to the nearest centimeter from average ground level to the base of the terminal bud, if present, or to the highest live point of the central stem if the terminal bud is missing.

Ovendry weight

Dry trees 48 hours at 70°C or until no further weight losses occur. Weigh the bulk sample to the nearest 0.1 gram.

Careful size and weight determinations are, of course, desirable, but extreme exactness is not needed to adequately establish average seedling size and dry weight.

Established photo points, from which to take pictures at every remeasurement, provide a highly informative adjunct to any study installation.

Survival and height growth data from a set of four plots may be analyzed statistically according to the following analysis of variance table:

Source of variation	Degrees of freedom
Plots (replications)	3
Stock types	1
Error	3
Subsampling	8
Total	15

If fall and spring planting comparisons are made in a particular set of plots, the analysis of variance table would be as follows:

Source of variation	Degrees of freedom
Plots (replications)	3
Seasons	1
Stock types	1
Interactions	1
Error	9
Subsampling	16
Total	31

When survival differs markedly between container and bare-root stock, statistical adjustments for unequal numbers may be necessary in later growth comparisons.

Form 1

PLANTING REPORT

Organization and admin. unit _____ Study no._____

Study location: T __ __, R __ __, S _____, _____

Stock characteristics	Containerized seedlings	Bare-root stock
Species & lot ident.		
Seed zone & elev.		
Stock age & root lgth.		
Container name & size		
Nursery name & facilities used (greenhouse, shadehouse, combination, etc.)		
Date lifted		
Date shipped		
Packaging (in containers, bags, boxes, etc.)		
Protective treatment(s)		
Type and duration of storage at work center		

Site description: Elev. (ft)_____ Slope (%)_____ Aspect_____

Unit size (ac)_____ Soil surface texture_____

Significant features (heavy competition, animal presence, shallow soil, etc.)_____

_____

_____

Planting conditions: Date(s)_____ Weather (temp., wind, cloud cover, precip.

_____

Soil moisture_____ Cohesiveness of containerized seedling root balls (plugs)_____

Tools used -- Containerized_____ Bare-root_____

Protective treatment applied_____

Planters initials: Plot 1_____, 2_____, 3_____, 4_____

Additional comments: (logging or fire history, site prep., previous reforest. attempts, comments on stock and planting conditions -- were seedling roots dry, planters new or experienced, tools satisfactory, etc.)._____

_____

_____

_____

Form 2

DESCRIPTION OF STOCK PLANTED

Organization and admin. unit_____ Study no._____

Study location: T __ __, R __ __, S _____, _____

Species_____ Sampled and measured by_____ Date_____

	Containerized seedlings		Bare-root stock		
	Ident. and general descript.:		Ident. and general descript.:		
Tree no.	Top lgth. (cm)	Stem diam. (mm)	Top lgth. (cm)	Stem diam. (mm)	Root lgth. (cm)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
Total					
Aver.					

Oven-dry weight (grams)

	Tops	Roots	Tops	Roots
Total				
Aver. wt./plant				

Form 3

SURVIVAL AND GROWTH RECORD

Organization and admin. unit _____ Study no. _____

Study location: T __ __, R __ __, S _____, _____

Plot no. _____ Row. no. _____ Date planted _____ Species _____ Stock type _____

Dir. row traveled _____ Recorder _____, _____, _____, _____

Tree no.	Date:			Date:			Date:			Date:		
	Surv.	Ht. (cm)	Cond.	Surv.	Ht. (cm)	Cond.	Surv.	Ht. (cm)	Cond.	Surv.	Ht. (cm)	Cond.
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
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16												
17												
18												
19												
20												
21												
22												
23												
24												
25												
Total												
Aver.												

CODING: Survival - 1 = live seedling
0 = dead seedling
M = missing

Condition - A = animal damage
FH = frost heaved
B = buried

NOTES: Use a separate form for each row to provide space for recording data from successive examinations. Record cause of mortality when known.

GPO 990-461